Compressed Air

DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

Vol. II. NEW YORK, AUGUST, 1897. No. 6


The United States of America

TO ALL TO WHOM THESE LETTERS PATENT SHALL COME:

Whereas John Gorrie of New Orleans, La.

Improved process for the artificial production of ice:

United States

COMMISSIONER of PATENTS

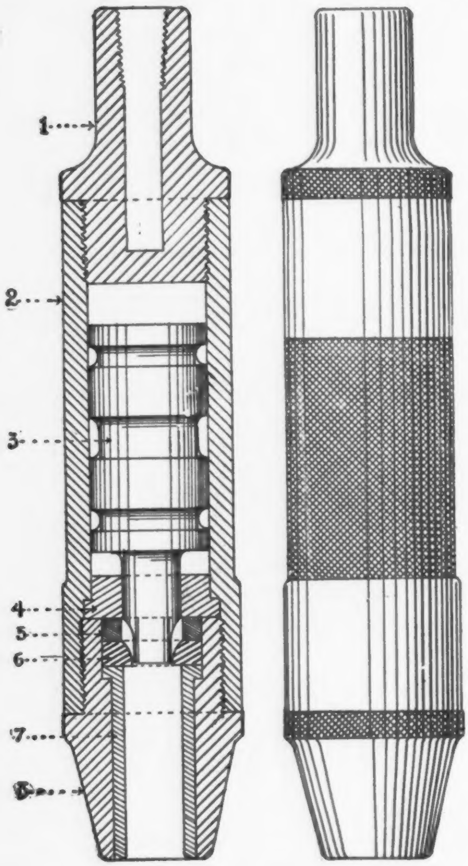
These are Therefore

John Gorrie

PATENT OFFICE

FAC-SIMILE OF PATENT ISSUED MAY 6, 1851, TO DR. JOHN GORRIE, FOR A MACHINE TO PRODUCE ARTIFICIAL REFRIGERATION BY COMPRESSED AIR.

Keller Pneumatic Stone and Metal Cutting Tool!



Parts

1. *Inlet piece*
2. *Cylinder*
3. *Hammer*
4. *Hammer Washer*
5. *Leather Washer*
6. *Tool Washer*
7. *Steel bushing*
8. *Nose*

Absolutely Valveless.

Patented November 12, 1895.
" May 26, 1896.

Furnished subject to ten days trial.

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Everything in the line of Pneumatic Equipment.

Compressed Air.

A MONTHLY PUBLICATION DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

W. L. SAUNDERS, - - Editor and Publisher
A. E. KENNEY, - - Managing Editor
J. E. QUINTERO, F. C. WEBER, - - - - - Associates

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We invite correspondence from engineers, contractors, inventors and others interested in compressed air.

All communications should be addressed to COMPRESSED AIR, 26 Cortlandt St., New York.

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Those who fail to receive papers promptly will please notify us at once.

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VOL. II. AUGUST, 1897. NO. 6.

Ignition in compressed air pipes, commonly known as firing, was referred to in these columns last month. We are not satisfied that the question has been thoroughly ventilated, hence further discussion of the subject seems advisable. Compressed air claims to be and is a safe power. Occasionally we hear of a case of firing, which to some may appear to be a serious objection to the use of air; but if the causes are known and understood and due care observed, firing becomes merely a matter of carelessness. A building made of wood is not considered unsafe because it will burn when ignited. Compressed air is not inflammable, but during compression by mechanical means it is found advisable to use oil, and this oil, or the gases from it, are the sources of combustion. In most cases firing may be traced to the use of poor oil, but in others too much oil sometimes causes ignition. It is a common mistake of engineers in charge of compressors to feed oil too rapidly to the air cylinder. It is simply necessary to supply oil enough to keep the interior of the cylinder and the moving parts moistened. Where steam is used there is a tendency to cut away the oil, hence engineers grow accustomed to feeding a larger supply than is required in an air cylinder. There is nothing to cut or absorb the oil in the air end; in fact, it is only after a considerable lapse of time that oil can get away when fed into the cylinder. There is no washing tendency as with steam, and a drop now and then is all that is required to keep the parts lubricated. Where too much oil is used there is a gradual accumulation of carbon, which interferes with the free movement of the valves and which chokes the passages, so that a high temperature may for a moment be formed and ignition follow. It is well to get the best oil, and to use but little of it.

There are cases where firing has arisen from the introduction of kerosene or naphtha into the air cylinder for the purpose of cleaning the valves and cutting away the carbon deposits. Every engineer knows how easily he may clean his hands by washing them in kerosene; and as this oil is usually available, we have seen men introduce it into the air cylinder through a squirt-can at the inlet valve. This is a very effective way of cleaning valves and pipes, but it is a source of danger, and should be absolutely forbidden. High grade lubricating oils are carefully freed of all traces of benzine, naphtha, kerozene and other light and volatile distillates. The inflammability of such oils is so acute that it is a dangerous experiment to introduce anything of this kind into an air cylinder; and if any of our readers have had an explosion in a case where the engineer uses kerosene, it may be traced to this source. Closed inlet passages leading to the air cylinder through which the free air is drawn from outside the building have many advantages, but one seldom thought of is that they interfere with the tendency of the engineer to squirt kerosene into the cylinder.

Soft soap and water is the best cleanser for the air cylinder, and it is recommended even in cases where the best oil is used. Long service will result in more or less accumulation of carbon; hence it is advised that engineers, once or twice a week or oftener if necessary, fill the oil cup with soft soap and water and feed it into the cylinder as the oil is fed.

Liquid Air and Its Uses.

Air is the vapor of a liquid and acts in its properties like the vapor of other liquids; for it liquefies at a pressure of 573 pounds per square inch with the temperature reduced to —220° Fah., and upon gradual release of pressure commences to boil at 294 lbs. pressure with a falling temperature, reaching —312° Fah. when the pressure is entirely released, at which temperature it will maintain its stability exposed to the atmosphere for some little time, according to the quantity under trial, and holding its intensely low temperature by its own evaporation until the whole is evaporated.

The critical point for air, or the temperature above which it will not liquefy by increased pressure, has been stated by Prof. Dewar to be —220° Fah. It has been compressed to over 14,000 lbs. per square inch without signs of liquefying at ordinary temperatures, and has been used for blasting rock and coal at 9,000 lbs. pressure.

Its use in physical experiments has been a most important one in developing the action of intense cold on the tenacity of metals, in chemical reaction and magnetic effect under temperatures approaching that of inter-planetary space.

The lowest temperature as yet artificially produced was obtained in the experiments of Professors Dewar and Wroblewski by the evaporation of liquid air by which a temperature of—346° Fah. was reached, or within 115° of the reputed absolute zero; beyond which, it is claimed, molecular vibration ceases and the chemical action between all substances are in abeyance.

In physical investigation the convenience for obtaining and maintaining intensely low temperatures for a considerable time or sufficient for the manipulation of experiments in physical phenomena is only of recent date, and this has opened the way for the most noted expansion in the paths of physical research.

The action of extreme cold on the tenacity of metals has become a most interesting inquiry, with results greatly contrasting with former theories and tending to show a critical temperature in the tenacity of metals not uniform, but widely varying with their crystalline structure.

Thus with steel, iron, copper, brass, German silver, gold, silver, tin and lead, the tenacity has been found to be largely increased from 60° Fah. to—295° Fah., mostly equal to 50 per cent., and in the case of iron to more than 100 per cent.; while the highly crystalline metals, zinc, bismuth and antimony, lose half their strength at the lowest temperature.

A singular incident is the increase in the tensile strength of the fusible alloy of tin, lead and bismuth of 300 per cent. at this low temperature.

The behavior of a magnet at the temperature of boiling liquid air has been found to be somewhat erratic, owing probably to the difficulties attending such experiments; but with final results of an increase of from 30 to 50 per cent. of its magnetic strength by the extreme cooling process.

In chemical research the field of operation at extreme low temperatures is so new that but few results of a positive character have been reached, owing to the chemical inertness of all the active elements, as with acids and alkalies.

At the lowest temperature yet reached, nitric acid has no action upon metals, and acids and alkalies may be mixed without evolution.

A most curious physical phenomenon is shown in the condition of meats at the extremely low temperature derived from the evaporation of liquid air; mutton becomes so exceedingly hard that it rings like porcelain when struck with an iron rod, and may be crushed into a fine dry powder with a hammer, in which muscle, fat and bone are undistinguishable, but mingled as dry sand.

Prof. McKendrick, in England, has found that microbic life in flesh is so tenacious that it cannot be frozen out, even after exposure to—133° Fah. for four days; that on thawing and raising to normal temperature and moisture, activity of life is at once manifested.

The commercial production of liquid air is a very important discovery, and the future question of economy in motive power may be intimately associated with this liquid. Compressed air, at pressures ranging from 1000 lbs. upward, is conducted from an air receiver through a small pipe, is refrigerated to expel its moisture, and is then conducted into the apparatus which liquefies it completely, without the use of chemicals of any kind, and it flows from this apparatus in a stream about the size of a lead pencil (in the apparatus of Linde) into a glass insulated receptacle, containing about two gallons. This receptacle was filled in a very short time. Of course, being in an open vessel, liquid air has no pressure, but its temperature is approximately —385° Fahr., or 445 degrees below the atmosphere at 60° Fahr. Inasmuch as it boils rapidly on the surface, owing to its absorption of heat from the atmosphere, it looks like carbonated milk on the surface, but upon dipping some of it out in a glass and observing its color through the glass, it has very much the appearance of ordinary water, and about the same weight. Its temperature is very deceptive, for as it runs from the condenser one may allow it to trickle over the fingers for a short space of time, and it appears to have the atmospheric temperature. The truth, however, of the matter is that it does not come in contact with the fingers at all; the hand being something like 480 degrees warmer than the liquid, it throws the liquid into a spheroidal state and interposes between it and the finger a film of atmospheric air. The sensation is very much like pushing one's hand into a bag of feathers or into a mercury bath, allowing, of course, for the difference in weight between the mercury and the liquid air. If, however, you immerse your hand in the liquid a sufficient time to establish a contact, the flesh would be burned, the same as if it were exposed to 440 degrees of heat, measured above the atmospheric temperature. If a test tube of 1½ inches diameter, having a couple of pounds of mercury in the bottom, is immersed in liquid air, the mercury will be frozen solid in a few seconds, and may be hammered out and otherwise manipulated the same as lead. An alcohol thermometer of large size will be frozen instantly upon being immersed in the liquid.

An idea of the tremendously low range of temperature may be gathered from the fact that it will take several minutes to thaw out the small bulb of this thermometer by covering it with the palm of the hand. It is one of the peculiarities of these substances at these low temperatures, that the surfaces were not sufficiently large to absorb heat fast enough to restore their condition, excepting after a considerable length of time.

A tablespoonful of liquid air poured on about a fluid ounce of whiskey will freeze it at once into flat scales, giving the whole the appearance and color of cyanide of potassium. This may be emptied out on a table, and will remain frozen in that condition for fully five minutes.

One thing that impresses one is that while all molecular motion is practically arrested at this temperature, the odor is perfectly distinct, showing that these particles which stimulate the sense of smell are active and independent of the temperature.

A teacupful of liquid air poured on top of a tank of cold water goes into its spheroidal state instantly, in globules of about half the size of an ordinary marble, which fly around on the surface, leaving a trail of white vapor behind them.

A handkerchief of either silk, linen or

cotton, saturated with the liquid, will be charred and destroyed just the same as if it were put in an oven and browned, though no change of color is apparent. Its evaporation is quite slow and it may be carried about for a number of hours in an open vessel without entirely disappearing. It probably represents a compression of about seven hundred atmospheres, and would, therefore, in a confined space, and at 60 degrees temperature, represent a pressure of somewhere from ten to twelve thousand pounds to the square inch.

Liquefying air is not a new thing; it has been performed by exerting enormous pressure or by freezing air to an unusual degree, or by a combination of pressure with refrigeration. There are so many uses to which liquefied air can be put that scientists hardly know where its usefulness will end if it can be produced at a low rate of cost in commercial quantities. This a new method and machine has accomplished.

Among other advantages, air in the portable, cheap form of a liquid, as it passes back to its ordinary state, can be used for illuminating purposes by mixing its escaping gases with atmospheric air in certain definite proportions. Moreover, as a driving force in the way of detonators, or explosive material to drive engines, liquid air is obviously a power that can be, under given conditions, profitably applied.

Hitherto the classic example of a method to liquefy air and obtain oxygen has been that invented by Beatty and Cailletet in 1877. With their machine, one began with carbonic acid gas. By means of a pump this gas was condensed in a tube, round which lay water at 10 deg. to keep the tube cool. The carbonic acid gas, being reduced to a very low temperature, passed from the first tube into another chamber with a tube in it, and in so doing fell to a lower temperature. Into this second tube was pumped at high pressure ethylene gas, which, in turn, fell to a low temperature, owing to the coldness of the carbonic acid gas bathing the tube. The ethylene gas was then passed from the second tube into a third compartment and fell further in temperature in so doing. The third compartment had likewise a tube with an air pump attached. Into this third tube was pumped oxygen gas and from the ethylene gas bathing it the oxygen gas reached a temperature of 192 deg. below zero. Finally, the oxygen was let out into a fourth compartment, in which was a fourth tube. The air pump attached to this fourth tube having filled it with condensed atmospheric air, the latter was so reduced in temperature that when it in turn was released from the tube, its cold was 273 deg. below zero, and it appeared in the form of drops like water.

This product, which is called liquid or fluid air, has a milky appearance from the presence of some carbonic acid gas, bubbles constantly, and from its enormous cold emits a smoke or cloud like the top of a very high mountain, and will only gradually resolve itself again into air when exposed to the ordinary atmosphere.

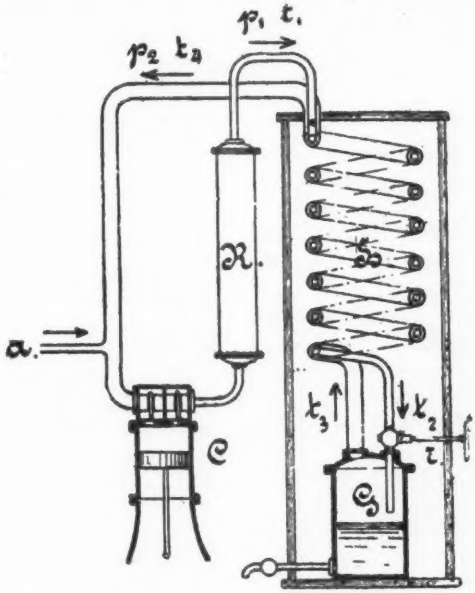
Fluid air costs about 10 marks (say $2.25) for 5 cubic meters reduced. The new method is the invention of Professor Linde of Munich. It produces the liquid for 10 pfennigs (say 2¼ cents) for 5 cubic meters, and it yields the product either as a gas or fluid, as one wishes. This is one of the most ingenious pieces of mechanism recently known; its chief feature is its economy of working, for it uses air to refrigerate air. After the pump has worked for a certain time, one turns a cock and the liquid air runs out at a temperature of 273 deg. below zero.

In Professor Linde's method, an air pump of 5 H. P. condenses air to a pressure of 200 atmospheres; this air passes down a spiral tube and is let out in a chamber, causing great cold; then it rises and passes on the outside of the spiral tube, bathing it and thus cooling the new air that has

been pumped into the tube to take its place. This cooled air follows on into the chamber, expands and again lowers its temperature, then passes on up around the same spiral tube; but as its temperature has become much lower, the new air in the tube is still further refrigerated. This circulating process goes on, until the new air pumped into the tube reaches the expansion chamber at a temperature of 273 deg. below zero, when it drops into the chamber in the form of liquid. Thus the air, steadily cooled, is made to refrigerate the newly pumped air more and more, until the necessary degree of cold is attained.

Another idea, which may or may not be an improvement, is to have the pump and all parts of the machine kept very low in temperature.

Air in the cheap, portable form of a liquid rich in oxygen can be used for many purposes in manufactures and the trades. The discovery of a cheap method may be of importance to American manufacturers.



THE LINDE METHOD OF LIQUEFYING AIR.

We illustrate the ingenious and simple apparatus used by Prof. Linde in Germany for liquefying air by a continuous process, in which a recompression of the cold expanded air is carried in a cycle of continually depressing temperature with an inlet of cold fresh air under pressure to compensate for contraction by compression and cold, until a temperature and pressure is reached by which a portion of the air liquefies and is held in the expansion chamber, from which it may be drawn off in a continuous stream, or as wanted.

In the Linde apparatus, as shown in our illustration, cold compressed air at 324 lbs. per square inch is furnished to the apparatus at (a), which establishes through the suction pipe and outer coil, a back pressure in the liquefying flask (G) of about 325 lbs. per square inch.

The compressor (C) is of the kind used for liquefying carbonic acid gas; it raises

the pressure from the suction side of 324 lbs. to 955 lbs. on its force side, from which the expansion is obtained for producing the low temperature required in the flask (G).

In subsequent experiments a pressure of 3000 lbs. per square inch has been used.

The high pressure air pipe enters the refrigerator (R) into a coil immersed in a circulating current of cold brine at about 10° Fah., which reduces the temperature of the high pressure air to about 15° Fah. The high pressure pipe then enters and is enclosed in the exhaust pipe of the apparatus in a coil containing 260 feet of 1½-inch pipe, the internal pipe size not stated, but probably ¾-inch pipe. The small pipe emerging from the large coil at the bottom, enters the liquefying flask with a regulating cock, as shown in the cut. The regenerating coil and flask being enclosed in a thoroughly insulated chamber, the operation may be as follows:

Taking the air from the primary compressor at 324 lbs. pressure and at normal temperature or less by artificial cooling, say to 30° Fah., the high pressure compressor carries the pressure with a third of its previous volume to, say 972 lbs., which will raise the theoretical temperature to, say 520° Fah.

This temperature should be so much absorbed by the refrigerator (R) as to allow at the start of the machine, of a temperature below the normal at the expansion nozzle in the flask. The expansion of the air from 972 lbs. to 324 lbs., say 3 volumes, or 43 atmospheres, reduces the temperature by expansion, theoretically, to about 400° below zero, Fah.; but in consideration that the material of the apparatus is at normal temperature and the specific heat of air being of low degree, a large part of this excessive cold must be absorbed in the material of the apparatus and its insulation, in order to bring the whole apparatus down to a p:o luctive temperature. This can only be done by operating the air in a cycle, by which the cold produced by expansion in the flask is utilized in the outer coil for reducing the temperature of the air in the inner coil. The time required for cooling the insulated apparatus to the temperature for producing liquid air in the flask was found to be 5 hours; when the machine became a constant producer of liquid air at the rate of six pounds per hour.

G. D HISCOX.

Air Brake Service.

The air brake is one of the applications of compressed air that has made a permanent place in its own field, and its development brings out some interesting facts in connection with train service.

During the three years that the high-speed brake has been in service on the Empire State Express not a single case of slid flat wheels has been reported. From 1886 to 1896 the distance required to bring a passenger train to a stop has been reduced one-half. This is due to the use of the high-speed brake instead of the plain automatic brake. The distance in which a train can be stopped from a speed of 40 miles is nearly twice as great as that from which it can be stopped from a speed of 30 miles an hour. To stop a train going at the rate of 50 miles an hour, the stopping distance is three times as great as that required at 40 miles an hour. At 60 miles an hour the distance required for stopping is about five times as great as that required for 30 miles an hour, and more than two and one-half times as great as that required at 40 miles per hour.

Work is now progressing on the construction of the Pneumatic Despatch System to connect the New York and Brooklyn Post Offices. The Batcheller Despatch System will be used to convey letters, parcels and other postal matter between these points. Tubes are being laid in Park Row, New York, to the Brooklyn Bridge and thence over the Bridge to Brooklyn and to the General Post Office.

COMMUNICATIONS.

Under this heading will be published inquiries addressed to the Editor of COMPRESSED AIR. We wish to encourage our readers in the practice of making inquiries and expressing opinions.

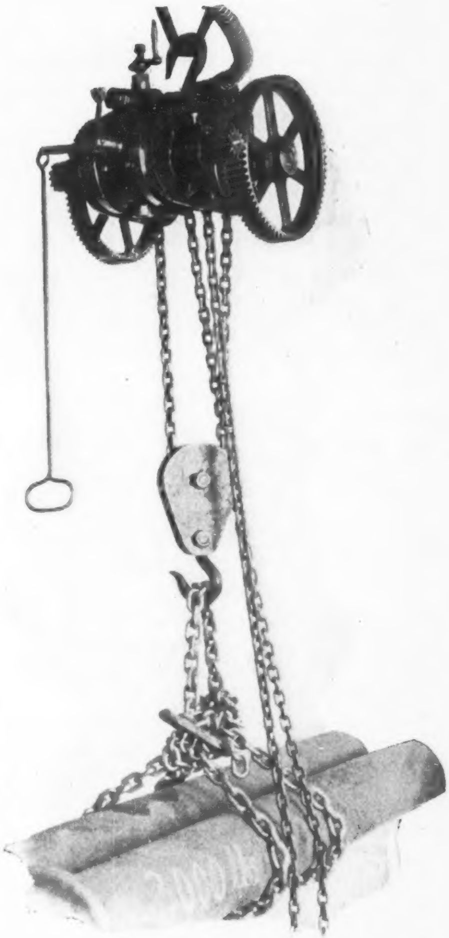
We request that the rules governing such correspondence will be observed, viz: all communications should be written on one side of the paper only: they should be short and to the point.

COMPRESSED AIR:

The article on air hoists in the last number of COMPRESSED AIR may have created a wrong impression on the minds of a great many people who do not use air hoists. Those who use straight lifts know the disadvantages of them and the difficulties attending their use. They also know their good points and what a saving in time and labor they effect with them. The people who do not use air hoists may get the idea that there is no air hoist on the market that will hold a load absolutely and without qualification or do successfully any or all the work of hoisting or lowering loads that may be required of it.

There is such an air hoist and we show a cut of it. This is the pneumatic motor hoist made by the Empire Engine and Motor Co. of 26 Cortlandt Street, New York City.

This is a hoist that will do any of the work required of an air lift or electric hoist and do it without the danger or difficulties attending their use for certain classes of work. In the first place there is a great saving of head room as there is no cylinder used, consequently no thought has to be given to the hoist itself in regard to length of lift wanted. The length of chain is its only limit of lifting. It will hoist accurately and steadily one quarter of an inch or twenty-five feet. The method of operating is exceedingly simple: the operator having perfect control of the motor at points. One of the strongest points made in favor of this hoist is its power of absolutely holding any load up to its full capacity at any point of the lift. This point is made without qualification, and the Company guarantee it. It is so constructed that it does not depend on the air pressure at all to maintain the load. In fact the motor may be detached from frame while load is suspended without affecting the load in the least. Then too in starting or stopping or in changing the weight of a load there is no vibration or jumping as in a cylinder lift, consequently no danger of blowing out cylinder heads or hose connections. Whatever the change of load the hoist will be



PNEUMATIC MOTOR HOIST.

steady and uniform. Another good feature about this hoist is that you can use it wherever you have the necessary eye bolt or hook; it is independent save for having to be near and within reach of the air pipes as a hand hoist. It is invaluable in foundries and all places where accurate and reliable work is required.

The motor used in this hoist is of exceedingly simple and durable construction, and is the same as that used by the Company in their portable reaming and drilling machines. It is reversible having to be reversed before chain or load can descend.

F. V. GREEN.

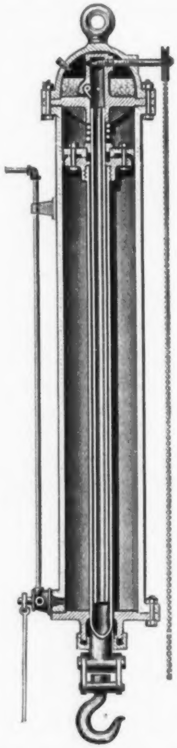
COATESVILLE, PA., July 28, 1897.
COMPRESSED AIR :

We have your July issue and note the wail of your correspondent. He is only one among hundreds. If you could get all the users of air hoists in Madison Square Garden, and read that to them there would go up such a hearty "Amen" that the roof would shake and graceful Diana on the tower would think she was back in Ephesus with Alexander the coppersmith.

If the piston of an air hoist is tight, and the valve don't leak, anybody knows that the load will be held indefinitely. But the great trouble is when a man gets to wanting an air hoist, he begins to ask "how cheap" instead of "how good." So instead of the hoist being made from cast iron and accurately bored out perfectly smooth as it should be, with a piston made with leather cup and cast iron backing, which backing should so nicely fit the bore that it nearly holds the air without any leather cup, instead of being made this way nearly all the small hoists are made from brass, iron or steel pipe which is so cheap and easy to make.

When made of brass the tubing is taken just as it comes from the mill, and is neither round or smooth like a bored cast iron cylinder. So the piston must be made a very loose fit, or it will stick while the pliability of leather is depended upon for it to adjust itself to the inequalities and roughnesses of the bore. Such a hoist will leak more or less of course, but for looks of work it will do fair service and it is cheap.

When steel pipe is used it is bored out, but because it is only a little more than ⅛ in. thick, it is hard to keep it round, rarely is bored round, and when the weld is made,



RIDGWAY OIL CONTROLLED HOIST.

always shows up more or less seamy when bored. The leather cup as in the brass pipe is expected to be obliging, and so such hoists while they must leak, for lots of work, will pass muster, and they are cheap.

Then to prevent these air hoists from becoming veritable air guns and shooting the piston through the roof or at least try to do it. When anything goes wrong, elaborate

valves must be used. In a little while these valves get leaky of course and the load wont stay where the owner wants it, and then goes up the plaintive cry we just now hear from your correspondent.

An air hoist needs but one simple valve, and that a cock like you use on your gas fixture which runs for years withou a smell, that is all and that is enough. To prevent jerkiness and running away when anything happens, such as the breaking of a chain or the careless throwing on a full head of air when there is no load, we submit our plan of oil governing by putting a quart or two of oil in the piston rod. This with our cast iron bored cylinders costs more than the pipe affairs and is worth more. Whether we can sell them depends; to be determined by how sick people are of the other sort. We have just put it on the market. It is a magnificent tool, but you know how things are, the fellow who makes the cheapest thing that will pass muster knocks the persimmon.

CRAIG RIDGWAY & SON,
Engineers, Founders and Machinists.

Editor COMPRESSED AIR :

In a certain experience with Air Compressors the question arose as to the quantity of water used by the water jackets on simple machines, and in the intercooler on compound machines, for example, take a simple machine 14" by 18", and a compound machine 10" by 12".

Take the temperature of water to be used at 60°, can you say how much water will be used by the water jacket on the simple machine, and how much will be used in the water jackets and intercooler combined on the compound machine? In the case mentioned the cost of water is, say, 8 cents per 1000 gallons, and used only to operate the compressors.

All water in excess of that used in the boiler was thrown away.

Figuring coal at $2.00 per ton and a boiler that will evaporate about 6 pounds of water to each pound of coal, I would like to have your estimate as to the cost of operating each machine. Yours,

CHICAGO. ENGINEER.

The question presented here is best solved by the use of a mathematical formula. However, as the average reader of this column might get a better understanding without the use of symbols, we will try to present the matter as clearly as we know how without them.

The amount of heat taken up by a pound of water has been determined experimentally a number of times, and is a matter of common knowledge to the engineer.

The increase in temperature in compressing air is also known, for every terminal pressure or it can be easily taken with a thermometer.

Having given both the temperatures of air, before and after compression, also the temperature of entering and exit jacket water, we can obtain the pounds of water required for every pound of air (say 13 cu. ft. free air) by dividing the rise in air temperature by the rise in water temperature and multiplying this quotient by 0.2375.

There is considerable radiation going on, however, from unjacketed cylinder heads, and the above product can safely be divided by 2 or 3 to give the weight of water necessary for assumed conditions of temperature.

It is common practice to use the jacket water as feed water for the boilers.

The following is from a recent test observation.

Temp. of air at inlet..................	78°
Temp. of air at discharge	356°
Rise in Temp. of air..................	278°
Temp. of entering jacket water........	46°
Temp. of leaving jacket water........	94°
Rise in Temp.........................	48°

$$\frac{278}{48}=5.8 \quad 5.8 \times .2375=1.37$$

$\frac{1.37}{2}=.68$ per pound of air.

Actual as found by test, .31 per pound of air. This is due to *very large* radiating surface in the plant tested and indicates

that 3 or 4 would be a better divisor in that case.

If much water is used its temperature will be but little increased in passing through the jacket, and if little water is used the temperature may rise 30° or 40° in the water, but as this would still be much colder than the air it would still play an important part in cooling the air. We give below a few actual conditions.

An 18" x 24" compressor (air pressure 80 pounds) used one pound of water per minute for every 14 cu. ft. of free air, and increased the temperature of water from 53° to 73°, so here it would have been better to use more water, say about a pound for 8 or 10 cu. ft. free air.

On a compound machine the quantity used was one pound of water per minute for 8 cu. ft. of free air, and increased temperature of water from 56° to 83°, or where more water was used, that is, one pound per minute to 2½ cu. ft of free air, the temperature would be increased from 56° to 66°.—ED.]

Editor "Compressed Air":

It is proposed to run a horseless carriage by compressed air, and the arrangement is to construct a light vehicle on the bicycle principle with a good air motor, using air reheated from a steel bottle compressed to a high pressure of 1,000 to 2,000 lbs.; this apparatus to be used for conveying persons from one point to another within a few miles.

For the information of myself and other readers who favor air whenever it can be used, will you please answer the following:

A pair of single-acting cylinders, 2½" diameter by 5" stroke, at 100 lbs. air. What power will this develop when air is heated so as to use it by expansion, and how long will a steel bottle of 2 cubic feet at 2000 lbs., run the engine, and what horse-power will it take to charge the bottle? Also, what revolution per minute would the engine run at its full horse-power? Could the air be used without heating, and would it freeze up the engine? W. J. E. CARR.

Leavenworth, Kans., July 16.

[Compressed air as a motive power has many economical and useful applications, but it has its limitations. Our hope in this direction seems to be confined to the possibilities that might result from the use of liquid air. At present there does not seem to be much encouragement in the use of compressed air for motor carriages. The limited space attainable and the weight of the apparatus seems prohibitive. A steel tube of one cubic foot capacity with air at 2,000 lbs. pressure (say 9" diameter), will contain 268 cubic feet free air, and power required to compress this quantity per minute will be 268 x .43 = 115 H. P.; or if done in one hour's time, will be 2 H. P.' and this calculation is based upon the very best type of 4 stage compressor with perfect intercoolers.

A pair of 2½" x 5" single-acting cylinders operating at 100 lbs. pressure, require each 32 cubic feet free air when running at best speed (say 400 revolutions per minute), so that out of a storage reservoir of 2 cubic ft. you will only get a run of about four minutes.

The weight of a Mannesmann steel tube 9" diameter, per cubic foot storage, is 82.2 lbs., and weight of 1 cubic foot air at 2000 lbs., is 10.2 lbs., making a total weight of 92.4 lbs. for every 2 minutes the carriage will run.—ED.]

CHARLESTOWN, MASS., Aug. 6th, 1897.

COMPRESSED AIR:

Some experiences in connection with the early use of compressed air at the Hoosac Tunnel may be amusing if not instructive.

It was clearly understood by those who were devising and building compressors and drills, that steam could not be used in Tunnel work.

The drills were simple and strong machines, the Burligh type being the first and I think, the only ones were there.

In the very beginning it was determined to put the drills in charge of the foreman of miners, instead of introducing a new element in the way of skilled or even common mechanics, with whom the other men would have no sympathy. It was thought more important to have men, who, through their experience, knew how to place holes which would do the most work, than to have men ignorant in this respect, though, familiar with the construction of the drills, which they could scarcely injure. This plan proved successful, and secured harmony all around.

But even while using compressed air, at the east end there were many who believed that steam would do just as well. In order to convince such, and secure uniform belief on this subject it was determined to make the trial.

A point was selected which was as near out of doors as any thing on the work, the central shaft. This was an ellipse in form, its axis being 27 and 15 feet respectively.

It was then down 74 feet from the surface. There were no means of compressing air at this point, but there was an engine of 100 horse power for hoisting, and 3 boilers, set up and in working order. So a drilling machine intended to be used with air was set-up on its tripod and the work begun. The escape steam was carried by a rubber hose into the water in the bottom of the shaft. The hose was shifted about from puddle to puddle, until all the water became boiling hot, and it became a very serious question where to find standing points. When the water under foot would take no more steam, it must of course take to the air, which soon became so thick that a man could not see his hands before his face, nor find air enough to breathe.

In addition to this the drills of course could not be directed aright, and they also became so hot that they could not be handled.

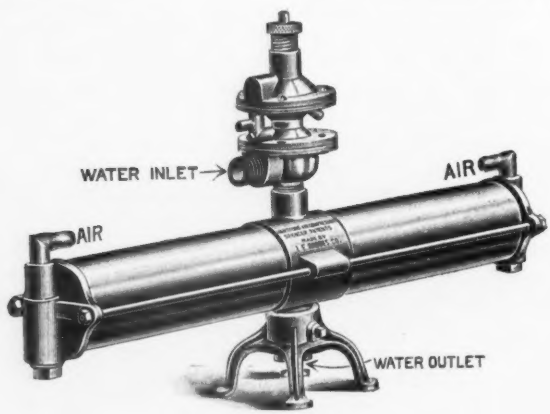
So by this simple and inexpensive trial, everybody was convinced, and no more talk about it was heard.

As in much of this world's experience, "seeing is beleiving." THOMAS DOANE.

The Hartford Air Compressor.

Some years ago recognizing the demand for an hydraulic air compressor that would do quick economical work without getting out of order easily, the L. E. Rhodes Co., of Hartford, Conn, began a series of experiments to devise something more simple and efficient than the pumps on the market. A pump of the double acting form was finally adopted, the designers believing that that class of compressor would do much quicker and more efficient work than either the single acting pumps with their wasteful springs or weights and their intermittent action, or the clumsy "tank" styles with their waste air space to consume power and their various floats and valves. The aim in the first place was to secure simplicity and next to prevent waste of water or air. How successful they have been in combining the advantages of the old pumps and eliminating their defects is realized when it is seen that in the Hartford Air Compressor there are less than half the parts usually necessary and no valve packings. The valve is a marvel of simplicity and efficiency and the entire force of the water is utilized for there are no narrow ways to choke and cause friction, with no weights to work against nor auxilary cylinders and waste air spaces to consume power. So it is claimed for this pump, that it will keep up the desired air pressure with less water than any other on the market. But the most noteworthy improvement to guard against waste is the system of regulating. The L. E. Rhodes Co. maintain that loss of speed must be the result where the ordinary practice is pursued of regulating down the pressure of the water (before it enters the compressor) to the desired air pressure and moreover that there is a great chance of leakage if the water is constantly bearing on the machine, whether air is being drawn or not.

Consequently they have adopted a device whereby the water is shut of entirely when no air is being used. As air is drawn the regulator automatically opens and allows the maximum water pressure to bear on the pistons, insuring such a quick action that the desired air pressure is immediately regained, which in turn causes the regulator to close. The benefit of the maximum water pressure is thus obtained to drive the pistons rapidly, and constant strain on the pump is avoided with its consequent leakage, for when the pump is not working the water is shut off as if by a faucet. The regulator is simple and easily adjusted.



HARTFORD AIR COMPRESSOR.

Long practical use has now substantiated the claims of the manufacturers that the Hartford Air Compressor gives a maximum coservice at a minimum cost for water and repairs. All the force of the water is utilized, insuring speed and very high efficiency, and there is no annoyance waiting for a tank or cylinder to empty and no waste of water through leakage. Extremely simple in design; with the troublesome springs and valve packings done away with; high grade in construction with a quick easy action and positive regulation, the Hartford Air Compressor truly seems an advance over anything yet devised.

Compressed Air Refrigeration.—The Earliest Ice Machine.

The earliest known appliance for making ice by compressed air, seems to have been invented and put into actual practice by Dr. John Gorrie of New Orleans, La.; whose patent dates May 6, 1851, although ice was actually made in his machine at Apalachicola, Fla., in the summer of 1850.

The machine consisted in its essential operating parts of an air compressing cylinder and piston operated from a crank-shaft by connecting rods.

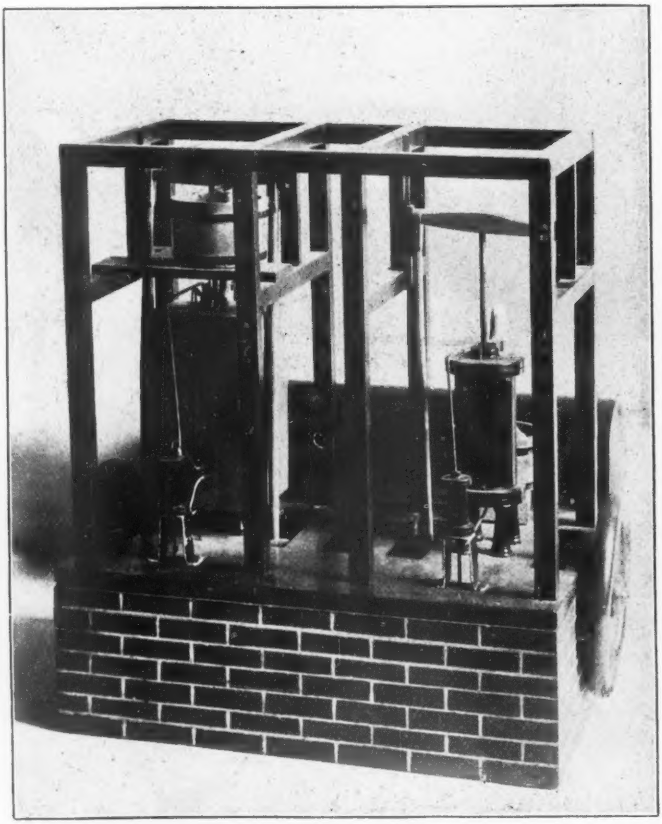
A small injection pump operated from a cam on the main shaft, so adjusted as to inject a small spray of cold water into the cylinder during the latter part of compression at each stroke of the piston; thus being the leading practical application of the injection system for cooling the air during compression; the compressed air and injected water being driven together through the exit valves and through a coil of pipe immersed in a tub of cold water, to the receiver, from which the injected and condensed water was drawn off through a waste cock at the bottom.

On the same platform and connected with a crank on the main shaft, was located the expansion cylinder with its piston and connecting rods.

The size of the expansion cylinder was made somewhat smaller than the compressor cylinder to compensate for the decreased volume of air due to the difference between adiabatic and isothermal values in compression and expansion for both cylinders.

The expansion cylinder was also provided with an independent injection pump operated from a cam on the main shaft by which an injection of a non-freezing liquid (brine) was made, which by the convection of its heat to the cold air, it becomes a cooling medium and was carried with the cold air through the exit valves and connecting pipe into the cold reservoir surrounding the cylinder.

The expansion cylinder being enclosed in a brine jacket with outlets for the cold exhaust and injection, through pipes terminating in the brine vat, for the purpose of utilizing the refrigerating effect of the expanded air for its full value; the free air finally permeating the ice making chamber above and an outer insulating case surrounding the brine tank and expansion cylinder made its exit through a coil in an insulated tank for cooling the water to be frozen, which was drawn from the cooling tank into the freezing cans of the form much in the style as now used and placed in the cold brine tank for the freezing operation.

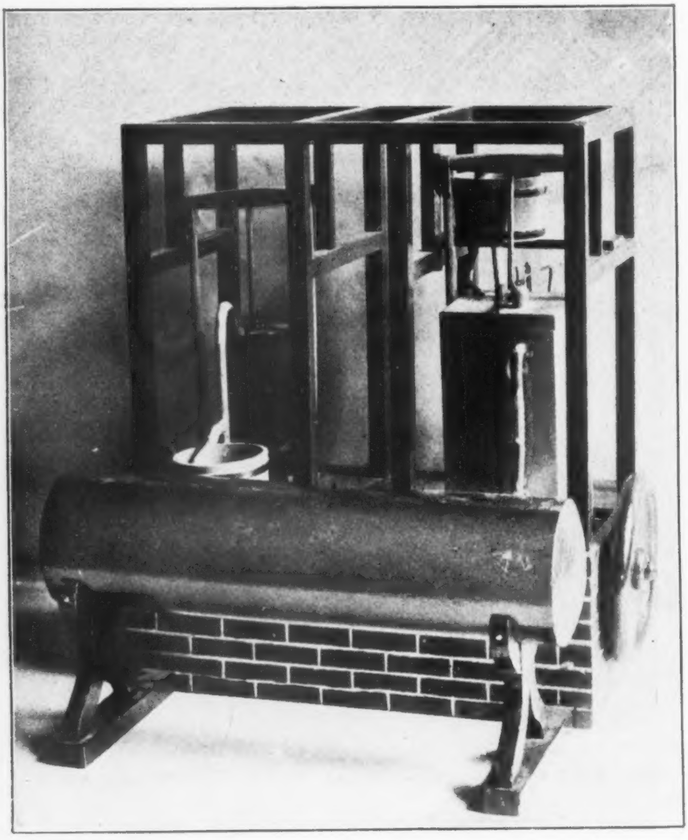


MODEL OF ICE MAKING APPARATUS.

It may be seen from the amply illustrated description in the patent specifications, and

from the testimony of persons that saw the apparatus, that Dr. Gorrie had conceived and put into practice a device almost perfect in principle for refrigeration by compressed air at least a score of years before it became a commercial factor in any form.

The idea of using the terminal exhaust for cooling the water to be frozen, to near



COMPRESSED AIR APPARATUS FOR MAKING ICE.

the freezing point was a most important one in the matter of economy.

The whole apparatus as completed in 1850 seems to have been the result of several years of study and experiment, and as now viewed was a most complete and advanced conception of the later developments of refrigeration by compressed air as made by Lightfoot, Hall, Bell and others in England and on the Continent, and by Hunt, Allen and others in the United States; for, in leaving out some parts of Dr. Gorrie's Machine, the principles of all the later machines are covered.

A reference to our illustration will show the details of construction of the compressed air freezing apparatus of Dr. Gorrie; the power for running the machine not being shown.

A. The air compressing cylinder.

B. Receiver or compressed air tank.

R. Cooling tank with air pipe coil P.

D. Injection pump for compressor spray, operated by cam and bell crank.

C. The expansion cylinder.

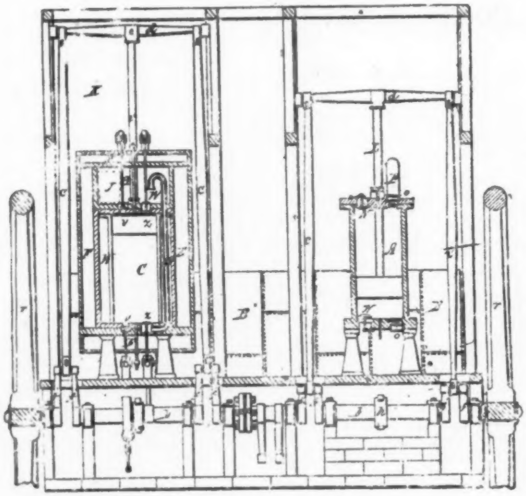


FIG. I.

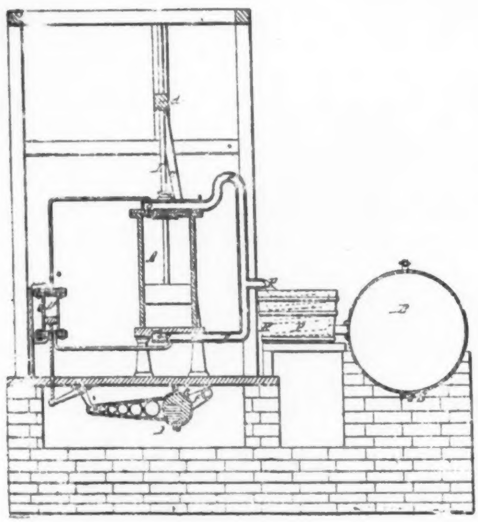


FIG. 2.

E. Expansion cylinder injection pump, drawing brine from the jacket W and forcing it in a spray into the expansion cylinder, by which the brine is quickly cooled and discharged with the cold air into the upper section of the brine jacket and tank.

J. The freezing can or tank.

A charging tank containing fresh water for supplying the freezing can, is placed overhead.

The other lettering indicates details readily understood by inspection.

PNEUMATIC APPLIANCES.

PATENTS GRANTED JULY, 1897.

Specially prepared for COMPRESSED AIR from the Patent Office files by Grafton L. McGill.

No. 585,927. — Air-Brake Mechanism.— Edward A. Trapp, New York, N. Y.

A pump supplies the main reservoir to which the engineer's valve is connected, said valve being also connected with the main pipe-line, from the reservoir, and its exhaust. The engineer's valve comprises a piston and plug-valve, both operated in one direction by a hand lever. The piston valve is exposed to the pressure in the reservoir, and controls the passage of air from the reservoir to the main pipe line, while the plug-valve, which is conical, is seated at its upper and lower ends at opposite sides of the passage through the valve casing through which air from the main pipe-line exhausts. On each car a signal and auxiliary reservoir are located. while the engineer controls the means for permitting the air in the reservoir to sound the signal.

No. 585,955.—Air Compressing and Cooling Apparatus.—John Flindall, Chicago, Ill.

This device comprises a by-chamber located in communication with a water-supply pipe. This by-chamber extends above the point to which it is filled by the water and has in the upper portion an air-inlet and outlet to control the flow of air, and also a pipe or cylinder into which the air is forced and compressed by the water which enters the by-chamber from the supply pipe.

No. 586,100. — Air Compressor.—Walter H. Knight, New Brighton, N. Y.

An air compressing cylinder is used in conjunction with a hydraulic pump, with which it has communication controled by air-valves. The liquid is caused to circulate through the hydraulic pump and air-compressing cylinder, instead of only into and out of the air-compressing cylinder.

No. 586,127.—Air Motor.—Joseph H. Hoadley, New York, N. Y.

This invention embraces the arrangement of the valves controlling the ports connecting the pistons with the source of fluid pressure supply. When the piston completes its stroke, the air compressed by the piston throws the cut-off valves open, while the pressure from the cylinder through cut-off ports closes the cut-off valves.

No. 586,155.—Pneumatic Sole.—Julia F. Bascom, South Milwaukee, Wis.

A removable shoe sole, hollow throughout, is provided with an expansible bag which is inflated with air.

No. 586,669. — Air Compressor. — Alfred Shedlock, Jersey City, N. J.

Two opposite pistons are alternately reciprocated by power from an interposed shaft on which is keyed a cup-shaped cam. One-half of this cam has a gradually increasing rise, and the remaining half falls and then rises. Connecting mechanism is located between the cam and the pistons for reciprocating the latter.

No. 586,946.—Pneumatic Press.—Philo C. Blaisdell, Bradford, Pa.

The cover of the cylinder has a centrally perforated port-face for a disk valve, inlet and exhaust ports of said face. The disk-valve has a central perforated stem and port for admission of air through the port-face. The valve is oscillated by its stem to control the cylinder ports. The cylinder has a vent at its upper end. The valve-stem has a vertically swinging arm which is connected with a foot-lever.

NOTES.

I am much pleased with your paper, and find it very interesting reading.

JOHN R. ALLEN, M. E.

Ann Arbor, Mich.

The June number of COMPRESSED AIR in transit to Europe was "damaged by immersion in sea water." The esteem in which the journal is held is shown by the prompt demand on the part of our subscribers for copies that were sound. It shows also that COMPRESSED AIR is kept by subscribers for reference, as an unsound copy will not do for that purpose.

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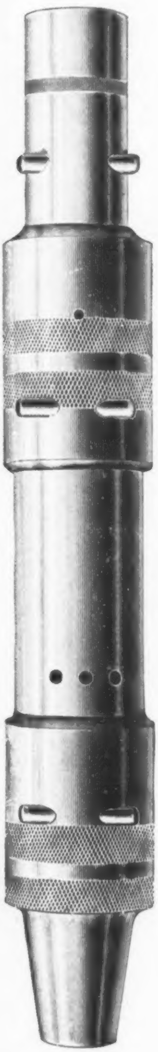

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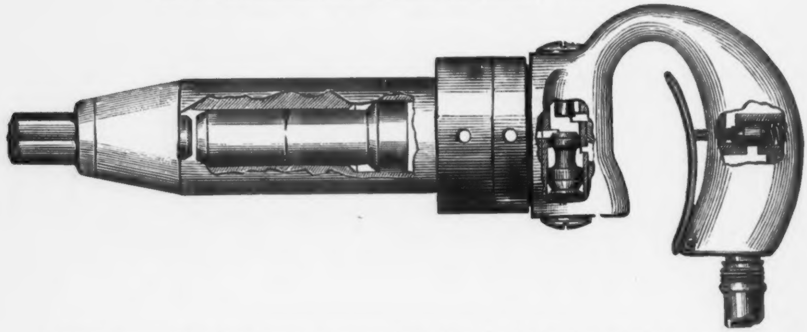

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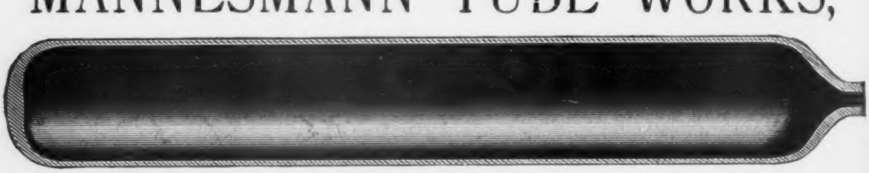

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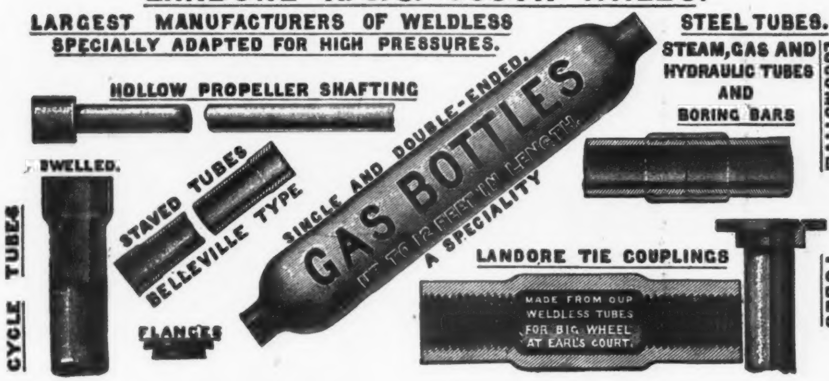

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